

A mid-upper tropospheric link between Asian summer monsoons and the tropical sea surface temperatures

Aiguo Dai[†]; Hongmei Li; Ying Sun; Li-Cao Hong; Ho Lin; Chia Chou; Tianjun Zhou

[†]NCAR, USA

Leading author: adai@ucar.edu

Previous studies have shown that tropical sea surface temperatures (SSTs) affect Asian monsoons through SSTs' impact on tropical convection, the Walker circulation and other near-surface processes. Using data from atmospheric re-analyses and model simulations, we show that Asian summer monsoon circulations are mainly driven by the land-ocean difference of geopotential height in the mid-upper troposphere (200-500hPa) rather than in the lower troposphere, and that tropical SSTs influence Asian summer monsoons mainly through their impacts on mid-upper tropospheric temperatures in the tropics and subtropics. Tropical SST anomalies associated the annual cycle, ENSO, decadal changes, and global warming all induce variations and changes in summer land-ocean thermal contrasts in the mid-upper troposphere (TCupper) that is highly correlated with the strength of the South Asian Summer Monsoon (SASM) and East Asian Summer Monsoon (EASM) in their respective sectors, but the strength of the monsoons decouple with the thermal contrast in the lower (500-850hPa) troposphere (TClower) in the global warming case. The results suggest that the TCupper plays a dominant role and provides an efficient mechanism through which tropical SSTs can influence extra-tropical monsoons. In climate models, the tropical mid-upper tropospheric temperature response is larger than SST anomalies due to convective latent heating; in atmospheric reanalyses, this enhancement is evident during ENSO events but missing for decadal changes that might result from data inhomogeneities. For the ENSO and decadal SST cases, the mid-upper troposphere at higher latitudes (30o-60oN) tends to exhibit temperature responses opposite to the tropical troposphere, thereby enhancing the TCupper changes and thus the impact on the monsoons. For warmer tropical SSTs, TCupper decreases which leads to a weakening of the SASM circulation. The opposite is true for colder tropical SSTs (e.g., during La Niñas).